AE62: **Sub-femtosecond bunch length diagnostic**

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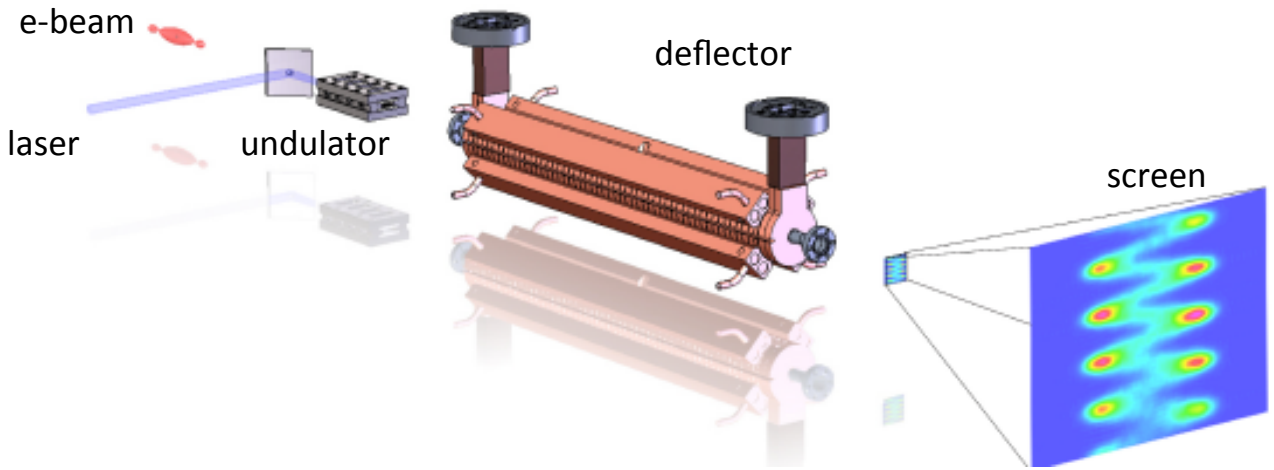
Status: * (Awaiting final technical report)

2019 ATF Users Meeting: Application for Continuation

(no experiment time received since the last users meeting)

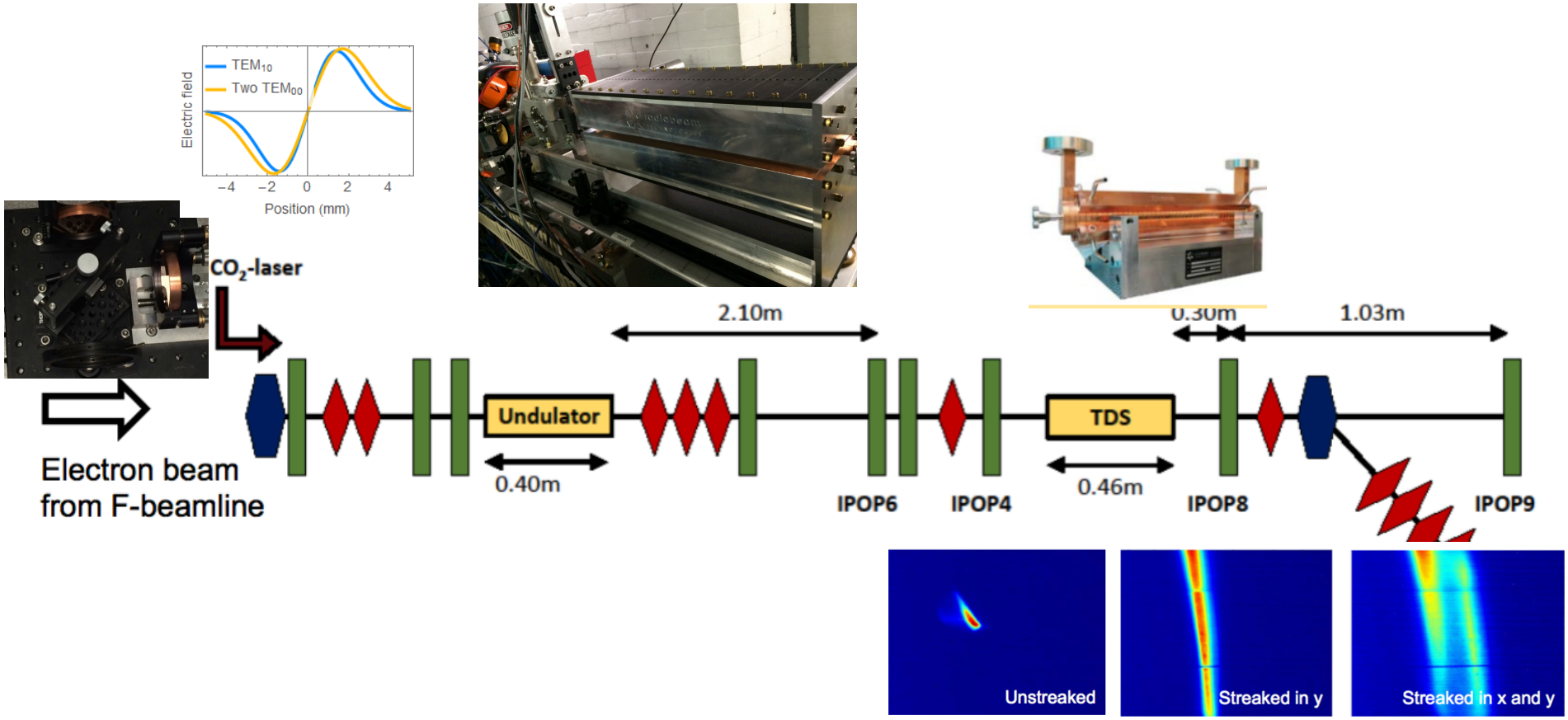
Science Case

Motivation: characterization of ultra-short bunches (sub-fs resolution)



- Laser (TEM_{10} mode)/e-beam interaction in undulator
  - Angular modulation of beam - Dependent on longitudinal coordinate
- RF deflector provides vertical streak for “slow” modulation
- Angular modulation (“sweep”) observable on distant screen (x’ -> x)
- Scheme provides enhanced resolution over RF deflector alone.
  - “Attoscope”

Experimental Setup



- Configuration is similar to prior IFEL/Attoscope runs (BL2)
  - Benefits from week's prior IFEL run (less install time)
  - New BL2 layout may require reconfig of mode converter

Plans

- No beamtime in 2018 - ATF not ready for both deflector and CO2 availability at same time
- Next run goal: Observe full modulation
  - Build off of previous results
  - Resolution on screen may be limiting
  - Deflecting voltage at TCAV,
  - Beam intrinsic emittance may need improvement (slits)
  - Deconvolve effects of beam transport
- Challenge: optimal laser and x-band simulation
  - Leverage off IFEL experiment (alignment, synchronization)
  - No new HW, reconfigure mod converter to accommodate new setup
- Request for next run
  - 1-2 weeks (Reestablish laser conditions & Realign/retune undulator)
  - 1-2 weeks run with laser + deflecting cavity
- Status: No cost extension expiring

Electron Beam Requirements

Parameter	Nominal	Requested Experiment Parameters
Beam Energy (MeV)	50-65	*44-48*
Bunch Charge (nC)	0.1-0.5	*.3-.5*
Compression	Down to 100 fs (up to 1 kA peak current)	*N/A*
Transverse size at IP (sigma, um)	30 − 100 (dependent on IP position)	*60um*
Normalized Emittance (um)	1 (at 0.3 nC)	*1*
Rep. Rate (Hz)	1.5	*1.5*
Trains mode	Single bunch	*single*

Special Equipment:

Deflecting cavity

CO_2 Laser Requirements

The following options are available at the laser source. Note that the maximum power available at your experiment interaction point will depend on the laser transport method.

OPTION 1 (full power, ~1 shot per minute)
regular gas in final amplifier (winter-spring 2018)
1 TW max (3.5 ps, 5 J, 30% of energy in post-pulses)
10.25 um
M^2 ~2
linear polarization

isotopic final amplifier (may be available late 2018)
2 TW max (2 ps, 4 J, single pulse)
9.25 um
M^2 ~2
linear polarization

OPTION 2 (regen only, 1.5 or 3 Hz)
3 GW max (2 ps, 6 mJ)
9.25 um
M^2 ~1.5
linear polarization (circular available at slightly reduced power)

Interaction Point location: Laser room/ electron experiment hall - *delete as necessary*

2018 Experiment Time Estimates

Run Hours (include setup time in hours estimate):80-120
Number of electron beam only hours:80
Number of CO_2 laser hours delivered to laser experiment hall ("FEL room"):0
Number of CO_2 laser hours, + ebeam, delivered to electron beam experiment hall:80

Overall % setup time:50%

Hazards & installation requirements:

Large installation (chamber, insertion device etc…): N
Laser use (other than CO_2): N
Cryogens: N
Introducing new magnetic elements: Y (undulator)
Introducing new materials into the beam path: N
Any other foreseeable beam line modifications: Y (slits for deflecting cavity)

Please describe further where necessary